GLDAS: AN IMPORTANT CONTRIBUTION TO CEOP

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Scientists at NASA's Goddard Space Flight Center (GSFC) have developed a high-resolution Global Land Data Assimilation System (GLDAS) in cooperation with researchers at NOAA's National Centers for Environmental Prediction (NCEP). The goal of GLDAS is to produce optimal output fields of land surface states and fluxes by making use of data from advanced observing systems (See figure on back page). Errors in land surface forcing and parameterization tend to accumulate in modeled land stores of water and energy, leading to incorrect surface water and energy partitioning. GLDAS aims to minimize this effect by constraining the models in two ways. First, by forcing the land surface, primarily by observations (such as precipitation and radiation), the biases in atmospheric model-derived forcing are avoided. Second, by employing land surface data assimilation techniques, observations of land surface storages (soil temperature, soil moisture, and snow depth/cover) can be used to steer unrealistic simulated storages towards reality. These techniques also enable identification and mitigation of observational errors and minimization of the impact of simplified land parameterizations. **The value-added data produced by GLDAS will improve land surface, weather, and climate predictions by providing global fields of land surface energy and moisture stores for initialization.**

Drivers have been installed in GLDAS for three land surface models (LSMs): Mosaic; the Community Land Model (CLM); and the NCEP, Oregon State University, United States Air Force, and Office of Hydrology model (NOAH). GLDAS runs globally with a 15-minute time step at 0.25° (soon to be 0.125°) and coarser resolutions. A vegetation-based "tiling" approach is used to simulate sub-grid scale variability, with the University of Maryland's 1 km global vegetation data set as its basis. Soil parameters are derived from 5-minute global soils information produced by USDA Agricultural Research Service. GLDAS uses the GTOPO30 global digital elevation model as its standard and corrects input fields accordingly. In addition to an operational, near-real time simulation using the standard parameterization and forcing data, several parallel simulations run with varying combinations of models, forcing data, and advanced options. Forcing options include the global atmospheric forecast model output (from GSFC's Data Assimilation Office, NCEP, and the Euro-observation-based precipitation and radiation fields. Advanced options, which are in various stages of planning, implementation, and testing, include a routine for satellite-based updates of leaf area index, canopy greenness and albedo, soil moisture and temperature data assimilation, observation-based snow corrections, simulation of the atmospheric boundary layer, and runoff routing.

The Coordinated Enhanced Observation Period (CEOP) was initiated by the international efforts of GEWEX and is focused on the measurement, understanding and modeling of water and energy cycles within the climate system. It is motivated by the synchronism of the new generation of Earth observing satellites and GEWEX Continental Scale Experiments (CSEs). Its primary goal is to develop a consistent data set for 2003-2004 to support research objectives in climate prediction and monsoon system studies. The requirements of the international climate research community at large have been taken fully into account in planning the assembly of the data set. CEOP also will assist studies of global atmospheric circulation and water resources availability. CEOP has gained the interest of a broad range of international organizations, as evidenced by the proposal for an Integrated Global Water Cycle Observations (IGWCO) theme within the framework of the International Global Observing Strategy Partnership (IGOS-P), which has re-affirmed CEOP as "the first element of the IGWCO." The CEOP implementation plan can be viewed at: http://www.gewex.org/ceop/ceop_ip.pdf.

CEOP aims to integrate the many streams of data coming from new space-based observation systems into a coherent database relevant to CEOP science issues, which will facilitate analytical investigations.

GLDAS is a valuable tool for CEOP because it assimilates the information from multiple models and observation platforms to provide the best available assessment of the current state of the land surface. The international GEWEX and CEOP communities have recognized that GLDAS can be leveraged and further developed to address the needs of CEOP. CEOP is specifically interested in the generation and application of GLDAS results in regional climate analysis, model initialization, and comparison with results from field campaigns and modeling experiments. The use of GLDAS model location time series (MOLTS), which are time series of land surface model output for points of interest, will be one of the primary tools to enable this globally-consistent intercomparison. Each GLDAS MOLTS will be particularly relevant because it will be generated based on a GLDAS subgrid "tile" with a vegetation class that matches that of the observation. Furthermore,

land surface models that GLDAS drives (currently three; five planned). These comparison exercises and the data produced by the continental scale experiments also will provide much-needed validation for the GLDAS project.

CEOP has requested that NASA further develop GLDAS as a central "CEOP data integration center", including the following aspects:

- A test bed for evaluating multiple land surface models.
- Long term land model baseline experiments and intercomparisons.
- Linking and inclusion of reference site observations with globally consistent observation and modeling to enable GEWEX-CSE land transferability studies.
- Land initialization for seasonal-to-interannual coupled predictions.
- Evaluation of numerical weather and climate predictions for land.
- Integration of remotely sensed land observations in land/atmospheric modeling for use in CEOP and higher level understanding.
- A quality control check on observations.
- 4DDA "value-added" GLDAS-CEOP data sets.
- The production of GLDAS MOLTS.
- The expansion of GLDAS to include selected atmosphere and ocean observations.
- The development of a long-term archive function.

The GLDAS contribution to CEOP is expected to have the following timeline:

- Data Integration Period (2002-2005): Compile the forcing data (observations and analyses) and assimilation data including radiance observations (level 1), high-level satellite data products, *in situ* observations, and NWP land analyses into a long term archive. Produce MLDAS (Molts LDAS) by reconfiguring GLDAS to run only MOLTS points for explicit linkages to CEOP reference sites.
- Reanalysis Period (2006-2007 work activity): Reprocess CEOP data in a globally consistent 1/8 degree resolution; global land reanalysis including multiple land model products (NOAH, CLM, VIC, etc.) and data assimilated value-added analysis.

For more information on GLDAS, please visit http://ldas.gsfc.nasa.gov.

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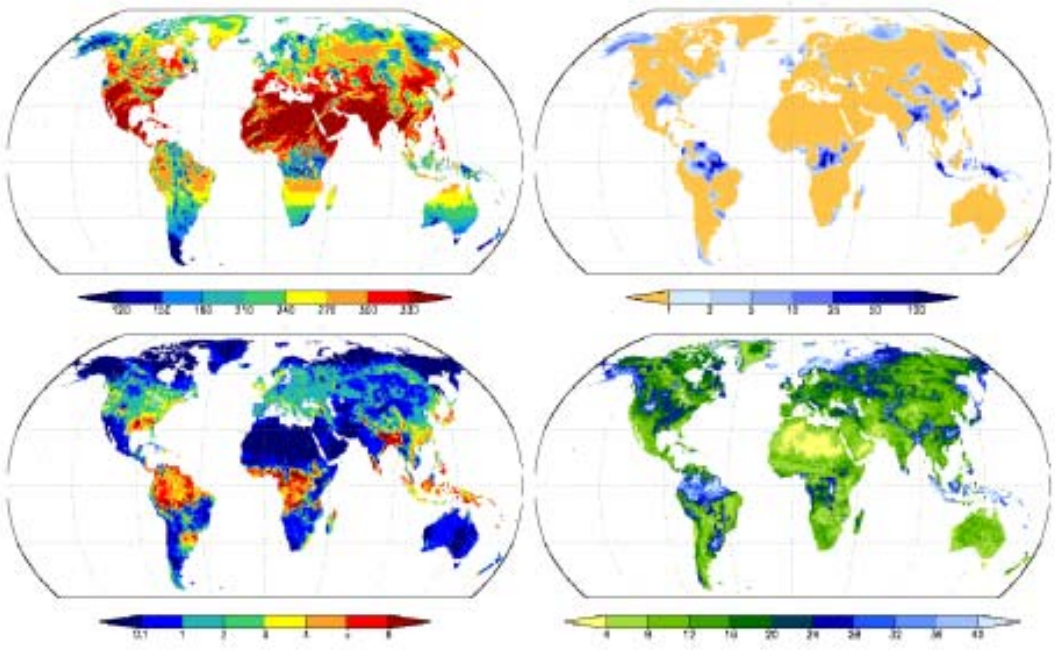

GLDAS forcing and output, 30 April 2002. Mean observation-based downward shortwave radiation [W/ m^2] (top left); total precipitation [mm] (top right); total evapotranspiration [mm] (bottom left); mean